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EMBRYOLOGY.[1]

ON THE POSITION OF THE YOLK-BLASTOPORE AS DETERMINED BY THE SIZE OF THE VITELLUS.—This principle, which I have to some extent elaborated elsewhere (Cont. Embryog. Oss. Fishes, p. 114), in so far as it applies to the ova of bony fishes of different species, differing greatly in the dimensions of the vitellus, may be expanded so as to throw some additional light upon the growth and closure of the blastoderm of other groups of Vertebrata. In the paper cited I have shown that the position of the point of closure of the blastoderm in relation to the original position of the germinal disk in Teleostei is to a large extent determined by the size of the vitellus, and consequently also stands in an intimate relation to the variation of the area of the vitelline surface over which the blastodermic membrane must grow, that is to say, with the increase of the superficial area of the vitelline globe upon which the germinal disk is superimposed, and over which it spreads as the blastoderm, the position of the yolk blastopore must vary.

A yolk blastopore is met with only in such forms of ova in which there is a distinct, unsegmented or partially segmented vitellus developed. As a rule, it does not coincide with the position of either mouth or anus, but when such a coincidence does occur the yolk blastopore answers nearly or quite to the permanent anus of the Vertebrate embryo. In the Vertebrates the yolk blastopore is apt in most cases to close behind the position of the permanent anus; in large-yolked cephalopod ova it closes at the anterior or perhaps more properly on the ventral face of the yolk-sack, and seems to have no relation to either mouth or anus. This is also the case with the yolk blastopore of the embryo of Sauropsida in which it closes far behind the point where the true blastopore is formed.

In a large Teleostean ovum, as in those of the larger Salmonoids and marine catfishes, the embryo ceases to grow in length when it has extended itself over an arc of the yolk globe of, say, 90° to 125°; in Alosa, an intermediate form, it extends its growth through an arc of 180° on the surface of the vitellus; in a third and still smaller type of ovum, that of Carassius, it may apparently grow to a greater length, and embrace an arc of 230° on the surface of the yolk sphere. In the first type that part of the rim of the blastoderm not yet incorporated into the body of the embryo and lying behind the latter may be drawn out into an oval, the anterior end of this oval area, over which the vitellus still remains uncovered, lying next the caudal extremity of the embryonic axis so far differentiated, as in Tylosurus and Elacate. This usually happens when the embryonic axis does not extend over a semicircumference of the vitellus, and when that half of the blastoderm opposite the embryo must grow in width more rapidly than the embryonic half in which the embryonic shield is formed.

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These different modes of the growth in length of the bodies of embryos of different species of osseous fishes may easily be verified by the observation of the progressive growth of the blastoderm of the living ova, and go far towards reconciling the differences of opinion which have been expressed by different observers as to the growth of the blastoderm over the yolk. It is at any rate evident that the manner in which this is accomplished in one form does not necessarily hold true of another.

It is very significant that two large-yolked types, viz.: the Sauropsida and Elasmobranchii should both have the embryo displaced in position in reference to the margin of the blastoderm. In the latter, the first traces of the embryo have the normal marginal position at the periphery of the blastoderm, but it is soon folded off, and before the yolk blastopore has closed, the latter finally closing a little way behind the stalk connecting the embryo and yolk sack. In the Sauropsida as held by Balfour, the primitive streak apparently represents the linear thickening between the lower vitelline stalk and the point where the blastoderm finally closed in the Elasmobranchii.

It is thus made evident that, whereas the embryonic axis in Teleostei, Chondrostei, Ganoidei, Petromyzon and Amphibia extends back to the point where the yolk blastopore closes, in Sauropsida and Elasmobranchii, the embryo is partially folded off, and the tail begins to bud out before the vitellus is included by the blastoderm, and while the end of the axis of the embryo is still remote from the opening of the yolk blastopore. This contrast between the two types, as will be evident to the thoughtful person, must be due to the great difference between the bulk of the yolks in the two cases. In the large-yolked forms if the embryonic axis were to continue to grow in length and extend quite to the point where the yolk blastopore closes, the body of the embryo would necessarily develop more somites than are present in the adult, so that growth in length of the embryonic axis ceases in the large-yolked forms far short of the point of closure of the blastoderm, covering perhaps only 30° of arc or less of the entire circumference of the vitelline globe. Such a small segment of the circumference of the vitelline sphere when contrasted with 90°–125°, and on up to 180° to 230°, embraced by the primary embryonic axis in Anamniate forms, seems inconsiderable, but is really relatively as extensive as in the latter.

The germinal disk of Sauropsida is relatively much larger than that of Teleostei, so that proportionally it probably does not spread over a much larger vitelline surface in the first case than in the last in order to include the vitellus, but as the blastoderm spreads in either case, it must be obvious to any one conversant with the mode in which the embryonic axis is formed during vertebrate development, that in the former growth in length of the axis would necessarily be completed before the blastoderm could spread over and include the yolk. Those forms of vertebrate embryos in which either the true or the yolk blastopore marks the end of the embryonic axis before the appearance of the tail bud might be called *teleporous*, while those in which there is no such coincidence, the yolk blastopore closing some distance behind or remotely away from the end of the embryonic axis, might be called, *ateleporous*. The first would include Amphibia, Petromyzon, Ganoidei, Chondrostei and Teleostei, the last, Elasmobranchs and Sauropsida. The ova of the two extremes of the vertebrate series Branchiostoma and Mammalia are yolkless, except those of Monotremata, which are probably ateleporous, simulating the Sauropsida in the general features of the development of the blastoderm and early phases of the embryo.

The band of tissue from the vitelline end of the umbilical stalk to the edge of the blastodermic rim in Elasmobranchii, and the primitive streak in Sauropsida and Mammalia are probably homologous structures. In the first instance it is formed by the concrescence of the margin of the blastoderm as it advances over the surface of the vitellus. In the Teleostei, Ganoidei[1] and Chondrostei it would seem that the whole of the margin of the blastoderm was used up by a process of concrescence to form the embryonic axis, whereas in the Elasmobranchii and Sauropsida there is a portion of the rim of the blastoderm remaining behind the embryo, which is not utilized in this way, but remains as the linear thickening of the former or as the primitive streak of the latter. While concrescence is not possible in the course of the development of the Sauropsida in the way in which it occurs in Ichthyopsida, it is known that the primitive streak is related posteriorly on either side to the *rand-wulst* or marginal thickening of the chick's blastoderm, a structure obviously homologous with the lower layer of the thickened margin of the blastoderm of the fish embryo. It is therefore interesting to note that an actual concrescence from behind forward of this rand-wulst or lower layer or a proliferation of cells from behind forwards would not be impossible. The *inner mass* of cells of the Mammalian ovum while in the vesicular or blastodermic stage is evidently in part homologous with some part of the thickened rim of the blastoderm of lower forms.

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[1] I regard the development of the germinal disk, embryonic axis and blastoderm of this type as being in no essential respect different from that of the Teleosts. The statements of Balfour and Parker, to the effect that the vitellus undergoes partial segmentation will probably be found to rest upon observations based upon material in which cracks were produced in the vitellus by reagents before the material reached their hands. The later stages show that I am right in this, the vitellus maintaining a relation to the body and intestine of the embryo quite like that observed in osseous fishes and totally unlike that noticed in the meroblastic ovum of Amphibians or Myzonts.

I am also unable to reconcile the figures given by Salensky and Professor W. K. Parker, of the fore part of the yolk-sack of the embryos of Acipenser. If the figures of the latter are correct, which they probably are, the intestine does not enclose the vitellus as represented by Salensky, but passes as a closed tube over the top of the yolk just as in Teleostean embryos, the development of the sturgeons in this respect, it will be seen, differs but slightly from that of bony fishes, a conclusion which is also supported by the way in which the yolk disappears as well as by its position in relation to the body of the embryo.

It is also a matter of great interest in this connection to observe that in the Sauropsida the rand-wulst or germinal wall is not carried along with the extreme edge of the epiblastic stratum quite to the border of the blastoderm all round as in Ichthyopsida. The epiblastic layer of the blastoderm in the Sauropsida rapidly extends beyond the lower layer or germinal wall, leaving it more or less remote from the outer margin of the germinal area. This peculiarity of development alone would be sufficient to cause the embryo to be formed away from the margin of the blastoderm in the Sauropsida, but even this I venture to suggest is to be explained by the increase in the size of the yolk of the ova of Sauropsida, the connecting link between the latter, and the teleporous Teleostean ovum being supplied by that of the Elasmobranchs, which probably represents at least one of the steps by which the evolution of the blastoderm of Sauropsida and Mammalia was attained, although it would obviously be incorrect to assume that these stages of blastodermic evolution were indicative of a serial or successional affiliation through descent. It would probably be much more rational to regard the development of these differences as being in the main due to an increase in the volume of the yolk as urged by Balfour, and that the causes of variations in its development were therefore to some extent mechanical in character.

The yolkless vesicular blastoderm of the higher Mammalia, or Eutheria, is obviously, as was supposed by Balfour, one which is to be regarded as having been derived from that of the Sauropsida. But no yolk blastopore is ever formed in the mammalian blastodermic vesicle, unless the blastopore of Van Beneden can be regarded as such. The blastopore of Van Beneden is obviously not the true blastopore, and if it can be regarded as representing the yolk blastopore, which seems very probable, the *inner mass* of cells finally involuted on its closure or covered over by the epibolic growth of the epiblast, and from which mass the mesoblast and hypoblast are derived, that mass becomes homologous with the marginal lower layer or *rand-wulst* of such a type as the Teleostean ovum.

The degeneracy of the vitellus of the ovum of Mammalia may possibly be due to the development of the so-called *uterine milk* from the uterine glands by which the egg is nourished from without during a very early stage and before the development of the area vasculosa or the vessels of the allantois is accomplished.

Intracellular digestion and growth is probably accomplished by some of the cells of the epiblast of the blastodermic vesicle, which send out pseudopodal processes between the cells of the uterine epithelium, as described by Caldwell in the case of the blastoderm constituting the yolk bag of the embryos of certain Marsupialia. Viviparity has not affected the development of the vitellus in the Teleosts, Gambusia, Zoarces and Embiotocidæ, where fœtal development is either intrafollicular or intraovarian. An albuminoid secretion is said by Blake to be found in the temporarily closed gravid ovaries of Embiotocoid fishes (*Journ. Anat. and Physiol.*, II, 280), and in this family as well as in some of the viviparous Elasmobranchs, it seems certain that the young developing viviparously are larger than can be accounted for by the size of the vitellus of the recently fertilized egg of the same species.

It therefore seems conceivable that the Mammalian vitellus, like the ambulatory, prehensile and other organs of parasitic organisms, may have been atrophied in consequence of the perfectly parasitic connection subsisting temporarily between the maternal organism and the embryo, as was supposed by Balfour. —*John A. Ryder.*

DEVELOPMENT OF THE SPINES OF THE ANTERIOR DORSAL OF GASTEROSTEUS AND LOPHIUS.—The important memoir of A. Agassiz before cited, shows that the spines of the anterior dorsal of the angler and stickle-back develop in distinct diverticula of the epiblast, a diverticulum being formed for each spine into which skeletogenous mesoblast is proliferated from its lower or proximal open end. These diverticula soon become free from the anterior end of the median dorsal fin-fold, the latter, in fact, seems to degenerate or be replaced by these diverticula, the first epiblastic diverticula to be developed are more or less translocated forwards from their original positions, so that in this way these dorsal spines are finally brought to rest on the roof of the skull of the adult, considerably in advance of the point where their development began on the nape of the embryo.

The formation of the singular dorsal appendage of the larva of Fierasfer according to Emery[1] is developed in a similar way as a dorsal epiblastic diverticulum, arising from the anterior end of the median dorsal fin-fold. The singular foliar appendages along its sides grow out secondarily. This transitory organ in Fierasfer is, however, much more precociously and rapidly developed than the bony, anterior dorsal spines of Lophius and Gasterosteus; its supporting axis is evidently mesoblastic in origin as in the latter, but degenerates just about the time of the final metamorphosis of the animal into the adult condition.—*John A. Ryder.*

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[1] Fierasfer. Studi intorno alla sistematica, l'anatomia e la biologia delle specie Mediteranee di questo genere. Reale Accad. dei Lincei. Ser. 3^a, Mem. Cl. di Sci., VII, 1880.